and Joule. If this last law, which practically amounts to a definition of *heat* as a dynamical quantity, coupled with a statement of the principle of conservation of energy, is to be admitted among the laws of motion, why should the second law of thermodynamics be excluded? In chapter vii. the author discusses the possible causes of loss of energy in the universe, but he might with considerable advantage introduce something about the degradation of available energy. This principle has an important bearing on the question of the infinity of the universe and the infinity of time. A finite universe cannot have existed for an infinite time past, radiating its energy into infinite space, but as soon as the principle of degradation of available energy is assumed, a similar difficulty as to infinity of time is found in dealing with an infinite universe, all of whose energy ultimately tends to be dissipated in the form of heat, and all of whose parts tend to a common temperature.

There is thus ample room for M. de Freycinet to write a further essay on the irreversible phenomena of Nature. There is another interesting field of study which he now mentions only in a footnote on p. 43, namely the existence of imaginary quantity and the remarkable fact that the generalisation of the laws of ordinary algebra requires the introduction of only one imaginary symbol. But, as the author points out, in the present state of science it is impossible for one man to survey our knowledge of more than a limited portion of natural phenomena. M. de Freycinet has given his readers much to think about in the domains of infinitesimal analysis and rational mechanics, and, moreover, this is written in a style which makes the book easy to read.

The Thermal Measurement of Energy. Lectures delivered at the Philosophical Hall, Leeds, by E. H. Griffiths, M.A., F.R.S. Pp. viii+133. (Cambridge: University Press, 1901.)

THIS little book consists of an account of four lectures, delivered to teachers by the author, at the request of the Technical Instruction Committee of the West Riding County Council. The author remarks that "The reflection that hundreds of such teachers should have been willing to sacrifice their Saturday afternoons to the study of certain physical measurements which did not even possess the charm of novelty may somewhat lighten the gloomy prospect sketched for us by those who hold pessimistic views as to the future of Intermediate Scientific Education in this country."

In attempting to render interesting a discussion of the thermal measurement of energy, Mr. Griffiths undertook a difficult task, which he has discharged admirably. There is no trace of the "popular lecturer" pure and simple; in his treatment of the subject success is due, not to an adroit avoidance of difficulties, but to the straightforward and conscientious attention given to every point of importance. In the first lecture, a number of well-chosen experiments are used to illustrate the conversion of work into heat. The second lecture is occupied with a consideration of the first and second laws of thermodynamics; incidentally the student is made acquainted with some of the difficulties attending thermometric determinations. In the third lecture an account is given of the principal methods which have been employed to determine the mechanical equivalent of heat. In this connection students will welcome the description of Reynolds and Moorby's determination, which has not as yet been dealt with in the text-books; it is to be regretted that more space could not be devoted to this valuable piece of work. A good account is given of Mr. Griffiths' own experimental test of the validity of the system of electrical units. Lecture iii. closes with a description of the recent experimental work of Callendar and Barnes on the variation in the specific heat of water.

The fourth lecture possesses very great interest. After remarking that text-books frequently give the specific heats of the metals to four of five decimal places, it is pointed out that these results necessarily depend for their accuracy on the values assumed for the specific heat of water at various temperatures. Generally speaking, authors content themselves with referring to Regnault's results, without, however, consulting Regnault's original papers. It appears that *only two* experiments were performed by Regnault for temperatures below 107°, and these were undertaken merely to test the working of the apparatus used, and Regnault himself attached no importance to them. As a matter of fact, Regnault performed a series of determinations of the changes in the specific heat of water *over the range* 107° *to* 190° C. After discussing the results, he stated what the nature of the variation between 0° and 100° would be if deduced by extrapolation from the experimental curve obtained at the higher range. Later investigations have proved these conclusions to be at fault, so that much otherwise unimpeachable experimental work relating to specific heats requires revision, and in many cases the data necessary for this purpose are not given by the authors.

It is finally recommended that the specific heat of water between 17° and 18° C. shall be defined as of unit value; this also amounts to defining the mean specific heat of water between 0° and 100° as of unit value. In that case the most probable value of the mechanical equivalent of heat is equal to $41{\cdot}84 \times 10^6$. E. E.

Instruments et Méthodes de Mesures Electriques Industrielles. By H. Armagnat. Pp. iii+614. (Paris: C. Naud.)

FEW, perhaps, realise how much electrical engineering owes its rapid development to the ease and precision with which the measurements it needs can be made. Yet it is this which renders it so amenable to mathematical and scientific treatment, and it is very largely owing to the fact that it can be so treated that it has progressed so rapidly. The manufacture of instruments has in many instances led rather than followed the development of the engineering side of the electrical industry. The practical engineer finds ready to his hand instruments for almost every conceivable purpose he may require, and it cannot be questioned that it is of the highest importance that he should properly understand their construction and limitations. M. Armagnat's book should therefore prove exceedingly useful to such men as a work of reference in which they can find a full discussion of the principles underlying the construction of the tools they use. As the author points out in his preface, beginners, and those also who habitually use instruments, are too often ignorant of their powers and of the proper way of treating them. Many mistakes, often of a serious nature, would be avoided if this state of affairs were remedied.

M. Armagnat describes both the instruments which are only to be found in electrical laboratories and those which are in daily and extended commercial use. It is the part of the book dealing with the commercial instruments which will commend itself more particularly to the practical engineer. The author has wisely confined himself to describing typical instruments of each class, and has refrained from giving descriptions of the numerous different examples of the type. Perhaps, however, an improvement would be introduced if instruments of different makes were compared, as this would serve as a useful guide to those who are in doubt as to what to purchase most suitable for their particular requirements. Valuable information is given as to the best methods of installing delicate instruments, of securing good illumination, freedom from vibration and outside disturbance, and of carrying out observations and measurements. The chapters devoted to these subjects add very greatly to the usefulness of the book, especially from the point of

view of the student. It may be said finally that the book is not merely useful as a work of reference, but it is thoroughly readable throughout. M. S.

Pleasures of the Telescope. By Garrett P. Serviss. Pp. vi + 200. (London: Hirschfeld Brothers, 1901.) Price 6*s.* net.

THIS book is the result of the collection under one cover of a series of articles originally published in serial form, after considerable revision and insertion of matter necessary to bring the information up to date.

Chapter i. deals in a very interesting manner with advice on the choice of telescopes, special characteristics of refractors and reflectors, principles underlying the achromatic corrections of refractors, and methods of testing the performance of astronomical instruments.

Following this, six chapters are devoted to a series of descriptions of the constellations, numerical particulars being furnished for all the more interesting objects. A very liberal supply of star-maps—twenty-six—serves for the identification of all the objects mentioned in the text.

The main features of the planets are also described, small cuts indicating the details to be seen with powers usually at an amateur's command. Four charts of the moon are given, showing the more important formations only, so as to avoid the confusion inseparable from the complete maps. This section is made exceedingly interesting by the various formations being compared with each other, the reader passing from one to another much more readily than by merely going over a list of objects. Users of the book will recognise the treatment of the subject as similar to that in "Astronomy with an Opera-glass," by the same author, and it will doubtless be welcome to many workers who only require information concerning objects within reach of the instruments usually possessed by amateurs; but the size of telescope catered for, of 5 inches aperture, is sufficiently large to render the information of service to the more advanced astronomer as well. There is only one slight criticism which may be suggested regarding the preparation of the star maps. On these there is no indication of either the coordinates of right ascension or declination. In actual practice, either in learning the constellations or in passing from one map to another, it is impossible to overestimate the help which is furnished by the graduated position lines. The legibility and general arrangement of the maps, however, are excellent and add greatly to the value of the book, which there can be no hesitation in recommending to the notice of all interested in observational astronomy. C. P. B.

Introductory Physics for Irish Intermediate Schools. By R. A. Gregory and A. T. Simmons, B.Sc. Pp. ix + 218. (London: Macmillan and Co., Ltd., 1901.) Price 2*s.*

THIS little book, as its emerald-green covers and title suggest, is for the use of Irish boys and girls preparing for the examination on the new syllabus in introductory physics issued by the Department of Agriculture and Technical Instruction. A glance at the book shows that Irish physics is the same as English, and those familiar with the other books prepared by the same authors will find here practically the same exercises. S. S.

Algebraical Examples. By H. S. Hall, M.A. Pp. viii +172. (London: Macmillan and Co., Ltd.) Price 2*s.*

IT will be a convenience to many teachers to possess this collection of algebraical exercises to supplement those given in Hall and Knight's "Algebra for Beginners" and "Elementary Algebra," up to quadratic equations. The exercises are carefully graduated, and are classified so that the teacher can easily select those referring to the subject with which he is dealing. In addition, there are a number of test-papers containing miscellaneous examples to test the pupil's grasp of the principles of algebra in which he has been exercised.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The FitzGerald-Lorentz Effect.

IN the January number of the *Philosophical Magazine* I published a discussion of the general theory underlying the experiment of Messrs. Michelson and Morley on the drift of the æther. As one result, it appeared that the effect to be expected in their special case was just the opposite of that usually supposed, and that consequently the FitzGerald-Lorentz explanation of the observed null effect would not hold. Mr. H. M. Macdonald has pointed out the source of this discrepancy in an algebraic slip in my paper; when this is corrected, the result comes into agreement with the special case treated by Michelson and Morley. The exact effect on the displacement of the interference-bands arising from a vertical component in the æther-drift has not been hitherto directly considered. It is probably null; but this requires verification, which I hope to be able to take up shortly on the basis of my analysis. As the question stands at present, the corrected result shows that the FitzGerald-Lorentz shrinkage would completely annul the shift when the drift is tangential. Although Dr. Larmor has not directly discussed the effect of an oblique drift in his "Aether and Matter," I understand from him that he has come to the conclusion (*cf. loc. cit.* § 34) that complete annulment results in all cases on the FitzGerald-Lorentz hypothesis. I think further discussion on the lines of my own method of analysis will verify that this is the case.

Meantime I send this intimation in order that others may not spend time in tracking out a discrepancy which has already been cleared up. W. M. HICKS.

University College, Sheffield, February 10.

Birds Attacking Butterflies.

ON July 22, 1901, a dull, sunless day, I pointed out to Prof. Gotch a fine fresh male specimen of the "Holly Blue" (*Lycaena argiolus*) at rest on the leaf of a shrub behind the Oxford University Museum. Touching it with my finger, the butterfly rose and fluttered feebly along the curved walk in the Parks. At that moment a swallow (or a martin) came down the walk from the opposite direction at full speed. It must have seen the butterfly fluttering towards it from a considerable distance; for with the most perfect ease and control it diverted its course and took the insect in its sweep. I felt, as I saw it, that only by good fortune was it possible thus to obtain the most direct evidence of events which are probably continually occurring.

There are, however, other means by which evidence can be obtained. One is the examination of the crops of dead birds. Although we should be sorry for British birds to be killed with this object (except in special circumstances), it is much to be hoped that the observations will be made when birds are killed, whether accidentally or otherwise. Mr. R. Newstead, of the Chester Museum, has done excellent work in this way; but there can be no doubt that, taking the country as a whole, only an insignificant proportion of the obtainable evidence is utilised.

Another line of evidence is afforded by specimens of butterflies which have their wings injured in a manner which is inconsistent with any interpretation except the snip of a bird's beak. Thus it is common to find fresh and unworn specimens with a notch or tear on the right side which exactly fits a corresponding injury on the left side, indicating that the wings had been torn when they were in contact. In one extreme instance, presented to the Hope Department by Dr. F. A. Dixey, a deep little notch had been cut out of all four wings of a "Red Admiral" (*Vanessa atalanta*), the four injuries exactly coinciding in the true position of rest adopted by this insect.

Oxford, February 2. EDWARD B. POULTON.

P.S.—Mr. W. Holland, of the Hope Department, tells me that about the middle of June 1901 he saw a swallow swoop down from a great distance and catch a white butterfly (almost certainly *Pieris rapae*) flying in front of the Museum. The bird took the insect in a single sweep and then dextrously avoided a